Thermal effects in graphene fatigue loading

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Mechanical characterization of graphene layers is a challenging topic.
Infrared thermal techniques supply a useful and consolidated way to investigate mechanical processes which involve energy exchanges and dissipations as elastic and plastic strain consist of. In mechanical applications these techniques are used for metal alloys, polymers and composites [1] to assess mechanical properties [2], damage [3, 4], plastic strain [5,6], crack nucleation and propagation [4, 7] in materials and components. In particular many researches have been developed about fatigue damage of metals and on the assessment of fatigue limit [8, 9]. The thermal behavior can be correlated to stresses and strain distribution and to thermoelastic and dissipation phenomena [10, 11]. Thermographictechnique was also applied for grapheme applications [12].
The main advantage of thermographic approach consists in a non contact full field real time measurement methodology.
In the present paper the mechanical fatigue behavior of graphene compoundsin polymeric specimens is presented from a thermal point of view.
Many polymeric specimen samples with different graphene composition undergo mechanical and thermal characterization.
Samples are flat injection-mouldeddogbone shaped, according to ASTM and UNI EN fatigue testing standards. Compounds were prepared by melt mixing of graphene nanoplatelets (GNP) in polyprobylene in a Brabender internal mixer at 190°C for 5 min at 100rpm using graphene nanoplatelets by Avanzare, Spain.
Monotonic and fatigue loadings are applied to specimens and the fatigue behavior of the layers is described and compared. An infrared camera is placed in front of specimens during testing. Thermal contours are acquired and processed. Room temperature is subtracted to obtain thermal surface increments during testing.
Preliminary tests show a different thermal behavior between pristine polymer and polymer/GNP. In particular a higher surface thermal increment is observed for polymer/GNP than for pristine polymer (fig. 1). A different thermal behavior is also observed for what concerns thermoelastic effectsin the two sets of specimens.

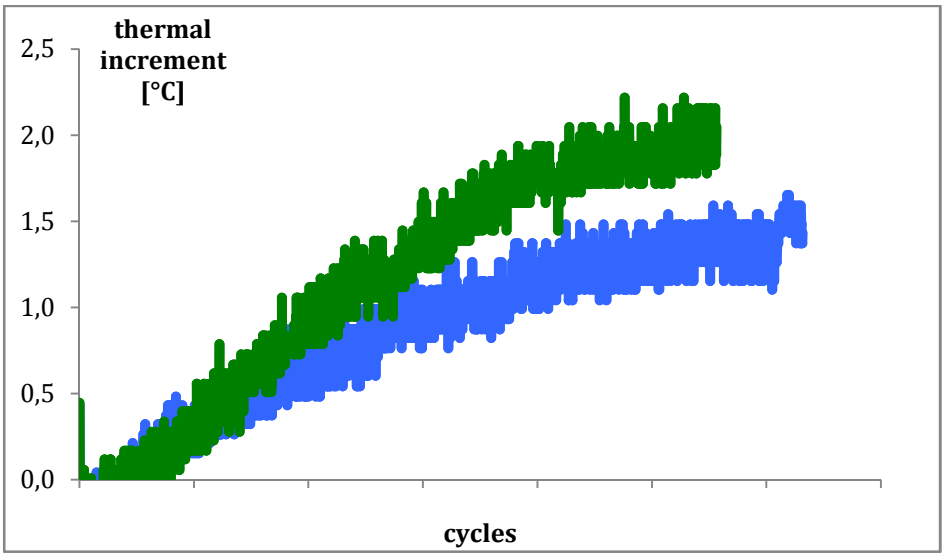

Figure 1: Surface thermal increment for polymer/GNP(green) and pristine (blue) specimens loaded at 10 Hz.

This research was supported by Graphene@PoliTo project

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